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## GEOMETRY.

Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.

### SOLUTIONS OF PROBLEMS.

52. Proposed by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pennsylvania.

If the center of a rolling ellipse move in a horizontal line, determine the surface on which the ellipse rolls.

Solution by G. B. M. ZERE, A. M., Ph. D., Professor of Mathematics and Applied Science, Texarkana College, Texarkana, Arkansas-Texas.

Let  $BPA$  be a quadrant of the ellipse semi-axes  $AC$ , and  $BC$ ,  $O$  the position of the center when  $BC$  coincides with  $OY$ , and  $\angle BCP = \theta$ . Then

$$PC = y = \frac{ab}{\sqrt{a^2 \cos^2 \theta + b^2 \sin^2 \theta}} = \frac{b}{\sqrt{1 - e^2 \sin^2 \theta}}.$$

$\therefore$  The ellipse rolls on the inner surface of the cylinder

$$y^2 + z^2 = \frac{b^2}{1 - e^2 \sin^2 \theta}.$$

When  $e=0$ , this becomes  $y^2 + z^2 = b^2$ .

To find the abscissa of the point of contact, we have, since  $\text{arc } PB = \text{arc } PG$ ,

$$ds = \sqrt{r^2 d\theta^2 + dr^2} = \sqrt{y^2 d\theta^2 + dy^2} \text{ since } PC = r = y;$$

$$\text{also } ds = \sqrt{dx^2 + dy^2}.$$

$$\therefore \sqrt{dx^2 + dy^2} = \sqrt{y^2 d\theta^2 + dy^2}.$$

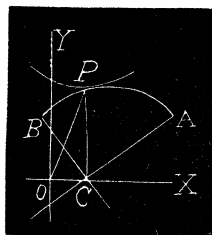
$$\therefore dx = y d\theta, \text{ or } x = \int y d\theta = \int \frac{bd\theta}{\sqrt{1 - e^2 \sin^2 \theta}} = bF(e, \theta).$$

When  $e=0$ ,  $x = b\theta$ .

[No other solution of this problem was received. EDITOR.]

53. Proposed by B. F. FINKEL, A. M., Professor of Mathematics and Physics in Drury College, Springfield, Missouri.

A pole, a certain length of whose top is painted white, is standing on the side of a hill. A person at  $A$  observes that the white part of the pole subtends an angle equal to  $\alpha$



and on walking to  $B$ , a distance  $a$ , directly down the hill towards the foot of the pole the white part subtends the same angle. What is the length of the white part, if the point  $B$  is at a distance  $b$  from the foot of the pole?

**Solution by G. B. M. ZERE, A. M., Ph. D., Professor of Mathematics and Applied Science, Texarkana College, Texarkana, Arkansas-Texas.**

Let  $DE$  be the length painted white; then a circle will pass through  $A$ ,  $B$ ,  $D$ ,  $E$ . Let  $\angle EAD = \angle EBD = \alpha$ ,  $AB = a$ ,  $BC = b$ ,  $\angle DAB = \angle DEB = \theta$ ,  $\angle ABE = \angle ADE = \varphi$ ,  $DC = y$ , and  $DE = x$ .

$$\text{Then } (x+y)y = (a+b)b \dots\dots\dots (1).$$

$$AE : a = \sin \varphi : \sin(\alpha + \theta + \varphi), \quad x : AE = \sin \alpha : \sin \varphi.$$

$$\therefore x = \frac{a \sin \alpha}{\sin(\alpha + \theta + \varphi)} \dots\dots\dots (2),$$

$$b : x + y = \sin \theta : \sin(\alpha + \varphi) \dots\dots\dots (3),$$

$$(x+y) : a+b = \sin(\alpha + \theta) : \sin(\alpha + \varphi) \dots\dots\dots (4).$$

Eliminating  $\theta$  between (3) and (4),

$$\left\{ \frac{(x+y)^4}{(a+b)^2} - \frac{2b(x+y)^2 \cos \alpha}{a+b} + b^2 \right\} \sin^2(\alpha + \varphi) = (x+y)^2 \sin^2 \alpha \dots\dots\dots (5).$$

Eliminating  $\theta$  between (2) and (3),

$$\begin{aligned} & [\{b^2 x^2 - x^2(x+y)^2\}^2 + 4a^2 b^2 x^2(x+y)^2 \sin^2 \alpha] \sin^4(\alpha + \varphi) \\ & \quad - 2a^2 \sin^2 \alpha (x+y)^2 \{b^2 x^2 + x^2(x+y)^2\} \\ & \quad \sin^2(\alpha + \varphi) + a^4(x+y)^4 \sin^4 \alpha = 0 \dots\dots\dots (6). \end{aligned}$$

Eliminating  $\sin(\alpha + \varphi)$  between (5) and (6) we get an equation in  $x$  and  $y$  which with (1) gives us the value of  $x$ .

Solved with result in terms of  $EC$  by *A. H. HOLMES*, and *FREDERICK R. HONEY*.

## PROBLEMS.

58. Proposed by *I. J. SCHWATT*, Ph. D., Instructor in Mathematics, University of Pennsylvania, Philadelphia, Pennsylvania.

1. The point of intersection  $K_a'$  of the tangent drawn to the circumcircle about the triangle  $ABC$  at  $A$  and the side  $BC$  is harmonic conjugate to  $K_a$  with respect to  $BC$ . ( $K_a$  is the point where the symmedian line through  $A$  of the triangle  $ABC$  meets the side  $BC$ .)

2. The point  $K_a'$  is the center of the Apollonius circle passing through  $A$  of the triangle  $ABC$ .

3. Grebes point is on the line joining the middle point of any side of a triangle with the middle point of the altitude to this side.

